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#### (57) Abstract

The invention relates to nucleic acids covalently coupled to electrodes via conductive oligomers. More particularly, the invention is directed to the site-selective modification of nucleic acids with electron transfer moieties and electrodes to produce a new class of biomaterials, and to methods of making and using them.

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CLASSIFICATION OF SUBJECT MATTER PC 6 C07H21/00 C12C A. CLASS IPC 6 C12Q1/68 C07H23/00 According to International Patent Classification (IPC) or to both national classification and IPC B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) C07H C120 IPC 6 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practical, search terms used) C. DOCUMENTS CONSIDERED TO BE RELEVANT Category ° Citation of document, with indication, where appropriate, of the relevant passages Relevant to claim No. WO 95 15971 A (CALIFORNIA INST OF TECHN) 1 - 2915 June 1995 cited in the application see claims 1-20; figures 1-4; examples 1-7 Υ R.P.HSUNG ET AL.: "Synthesis and 1-29 CHaracterization of Unsymmetric Ferrocene-Terminated Phenylethynyl Oligomers." ORGANOMETALLICS, vol. 14, no. 10, 1995, pages 4808-4815, XP002077968 cited in the application see the whole document Υ WO 93 10267 A (IGEN INC) 27 May 1993 1-29 see abstract; claim 1 -/--Further documents are listed in the continuation of box C. Patent family members are listed in annex. 2 Special categories of cited documents : "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international "X" document of particular relevance; the claimed invention filing date cannot be considered novel or cannot be considered to "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) involve an inventive step when the document is taken alone document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such docu-"O" document referring to an oral disclosure, use, exhibition or ments, such combination being obvious to a person skilled in the art. document published prior to the international filing date but later than the priority date claimed "&" document member of the same patent family Date of the actual completion of theinternational search Date of mailing of the international search report 18 September 1998 01/10/1998 Name and mailing address of the ISA Authorized officer European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo ni, Scott, J Fax: (+31-70) 340-3016

Inte Ional Application No
PCT/US 97/20014

0.10 - 12	AND COMMENTS CONCINCION TO BE SELEVANT	701/03 9//20014
C.(Continu	ation) DOCUMENTS CONSIDERED TO BE RELEVANT  Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 90 05732 A (THE TRUSTEES OF COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK) 31 May 1990 see the whole document	1-29
Υ .	WO 94 22889 A (CIS BIO INT ;TEOULE ROBERT (FR); ROGET ANDRE (FR); LIVACHE THIERRY) 13 October 1994 see abstract; claims 13-18; examples 6-8	1-29
Υ	TURRO N J ET AL: "PHOTOELECTRON TRANSFER BETWEEN MOLECULES ADSORBED IN RESTICTED SPACES" PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON PHOTOCHEMICAL CONVERSION AND STORAGE OF SOLAR ENERGY, 1990, pages 121-139, XP002041921 see the whole document	1-29
Y	MURPHY C J ET AL: "LONG-RANGE PHOTOINDUCED ELECTRON TRANSFER THROUGH A DNA HELIX" SCIENCE, vol. 262, 12 November 1993, pages 1025-1029, XP002041920 see the whole document	1-29
А	AIZAWA M ET AL: "INTEGRATED MOLECULAR SYSTEMS FOR BIOSENSORS*" SENSORS AND ACTUATORS B, vol. B24, no. 1/03, PART 01, March 1995, pages 1-5, XP000521315 see abstract	1,9
Α	J.R.REIMERS ET AL.: "Towards Efficient Molecular Wires and Switches: The Brooker Ions." BIOSYSTEMS, vol. 35, 1995, pages 107-111, XP002077969 see the whole document	1,2,9
P,Y	WO 96 40712 A (CALIFORNIA INST OF TECHN) 19 December 1996 see claims 1-27; examples 1-8	1-29
P,Y	W.M.ALBERS ET AL.: "Design of Novel Molecular Wires for Realizing Long-Distance Electron Transfer." BIOCHEMISTRY AND BIOENERGETICS, vol. 42, 1997, page 25-33 XP002077970 see the whole document	1-29
P,Y	US 5 591 578 A (T.J.MEADE ET AL.) 7 January 1997 see the whole document/	1-29

Intr Ional Application No PCT/US 97/20014

.(Continu	tinuation) DOCUMENTS CONSIDERED TO BE RELEVANT					
ategory '	Citation of document, with indication,where appropriate, of the relevant passages		Relevant to claim No.			
	P.LINCOLN ET AL.: "Short-Circuiting the Molecular Wire." JOURNAL OF THE AMERICAN CHEMICAL SOCIETY., vol. 119, no. 6, 1997, pages 1454-1455, XP002077971 DC US see the whole document		1,9			

Information on patent family members

Int tional Application No PCT/US 97/20014

	tent document in search report	;	Publication date		Patent family member(s)	Publication date
WO	9515971	A	15-06-1995	US	5591578 A	07-01-1997
				AU	1215295 A	27-06-1995
				CA	2178618 A	15-06-1995
				EP	0733058 A	25-09-1996
				JΡ	9506510 T	30-06-1997
				ÜS	5770369 A	23-06-1998
				ÜS	5780234 A	14-07-1998
				ÜS	5705348 A	06-01-1998
۳O	9310267	 A	27-05-1993	 AU	658962 B	04-05-1995
	3310207		27 00 1330	AU	3141293 A	15-06-1993
				CA	2100159 A	16-05-1993
				EP	0567635 A	03-11-1993
				ĪĹ	103754 A	15-04-1997
				JP	2788786 B	20-08-1998
				JP	6507316 T	25-08-1994
	•			US	5635347 A	03-06-1997
				ZA	9208839 A	13-05-1993
 WO	9005732	 А	31-05-1990	US	5112974 A	12-05-1992
	,,,,,,,	••		AU	4647689 A	12-06-1990
				CA	2002380 A	07-05-1990
				US	5439794 A	08-08-1995
WO	9422889	A	13-10-1994	FR	2703359 A	07 <b>-</b> 10-1994
				AT	159028 T	15-10-1997
				DE	69406119 D	13-11-1997
				DE	69406119 T	26-03-1998
				. DK	691978 T	25-05-1998
				EP	0691978 A	17-01-1996
				ES	211 <b>0</b> 228 T	01-02-1998
				GR	302 <b>573</b> 8 T	31-03-1998
				JP	8508311 T	03-09-1996
WO	9640712	Α	19-12-1996	AU	6166296 A	30-12-1996
				US	5770369 A	23-06-1998
US	5591578	Α	07-01-1997	AU	1215295 A	27-06-1995
				CA	2178618 A	15-06-1995
				EΡ	0733058 A	25-09-1996

Information on patent family members

Inte Ional Application No
PCT/US 97/20014

Patent document cited in search report	Publication date	Patent family member(s)		Publication date	
US 5591578 A	, , , , , , , , , , , , , , , , , , , ,	JP	9506510 T	30-06-1997	
		WO	9515971 A	15-06-1995	
		ÜS	5770369 A	23-06-1998	
	•	US	5780234 A	14-07-1998	
		US	5705348 A	06-01-1998	

Form PCT/ISA/210 (patent family annex) (July 1992)